Available online at www.sciencedirect.com
ScienceDirect
Theriogenology 72 (2009) 747–754
Theriogenology
www.theriojournal.com

Effect of natural or vaccine-induced porcine circovirus type 2 (PCV2) immunity on fetal infection after artificial insemination with PCV2 spiked semen

D.M. Madson [a], A.R. Patterson [a], S. Ramamoorthy [a], N. Pal [a], X.J. Meng [b], T. Opriessnig [a,*]

[a] *Department of Veterinary Diagnostic and Production Animal Medicine, College of Veterinary Medicine, Iowa State University, Ames, IA, USA*

[b] *Department of Biomedical Sciences and Pathobiology, Center for Molecular Medicine and Infectious Diseases, College of Veterinary Medicine, Virginia Polytechnic Institute and State University, Blacksburg, VA, USA*

Received 25 February 2009; received in revised form 14 April 2009; accepted 19 April 2009

Abstract

The objectives of this study were to determine if vaccination against porcine circovirus type 2 (PCV2) or previous PCV2 infection of the dam are sufficient to prevent fetal infection when dams are artificially inseminated with PCV2-spiked semen. Nine sows (Sus domestica) were allocated into three groups of three dams each: The PCV2 naïve negative control Group 1 was artificially inseminated with extended PCV2 DNA negative semen during estrus, whereas the extended semen used in the vaccinated Group 2 (PCV2 vaccine was given 8 wk before insemination) and PCV2-exposed Group 3 (infected with PCV2 12 wk before insemination) was spiked with 5 mL of PCV2 inoculum with a titer of $10^{4.2}$ tissue culture infectious dose ($TCID_{50}$) per milliliter at each breeding. The dams in the vaccinated and PCV2-exposed groups were positive for PCV2 antibody but negative for PCV2 DNA in serum at the time of insemination. Three negative control dams, two vaccinated dams, and three dams with previous PCV2 exposure became pregnant and maintained pregnancy to term. After artificial insemination, viremia was detected in one of three vaccinated dams and in two of three dams with previous PCV2 exposure. At farrowing, PCV2 infection was not detected in any piglets or fetuses expelled from the negative control dams or from dams with previous PCV2 exposure. In litters of the vaccinated dams, 15 of 24 live-born piglets were PCV2 viremic at birth, with 6 of 26 fetuses having detectable PCV2 antigen in tissues. In conclusion, vaccine-induced immunity did not prevent fetal infection in this sow model using semen spiked with PCV2.

Keywords: Artificial insemination; Fetal infection; Immunity; Porcine circovirus type 2; Vaccine

1. Introduction

Reproductive failure is one of the multiple disease entities, known as porcine circovirus-associated disease (PCVAD), associated with porcine circovirus type 2 (PCV2) infection [1]. Porcine circovirus type 2 is a small, nonenveloped, circular, single-stranded DNA virus in the family Circoviridae [2]. Reproductive failure associated with PCV2 in pregnant swine may clinically result in acute systemic illness in the dam, abortion, increased nonviable fetuses at parturition (mummified and stillborn fetuses), or weak born piglets [3–5] and has typically been reported in gilts or in co-mingled pregnant females [6,7].

* Corresponding author. Tel.: +1 515 294 1950; fax: +1 515 294 3564.
E-mail address: tanjaopr@iastate.edu (T. Opriessnig).

0093-691X/$ – see front matter © 2009 Elsevier Inc. All rights reserved.
doi:10.1016/j.theriogenology.2009.04.024

In the pregnant dam, PCV2 is capable of crossing the placenta during viremia and infecting fetuses in utero [4]. In early- to mid-gestation fetuses, PCV2 has a predilection for myocardial tissue [8], resulting in myocardial necrosis, nonsuppurative myocarditis, and fibrosis [5]. However, if fetal infection occurs during late gestation, myocardium is less affected and more PCV2 DNA can be detected in lymphoid tissue [9]. Porcine circovirus type 2 can spread from fetus to fetus in utero, resulting in death at various stages of gestation. Occasionally, affected fetuses have gross lesions of heart failure, which may include an enlarged globose heart, congested liver, pulmonary edema, ascites, and increased thoracic fluid [10].

The source of PCV2 in reported cases of reproductive failure is often unknown, although boars can shed infectious PCV2 in semen [11]. Recently PCV2-associated reproductive failure was reproduced in PCV2 naïve dams using semen spiked with PCV2 for artificial insemination (AI) [10]. In that experiment, dams carried pregnancy to term without clinical signs but delivered increased numbers of mummified fetuses, stillborn fetuses with gross lesions of heart failure, and live-born piglets that were PCV2 viremic at birth, indicating that dam and fetal PCV2 infection can be associated with contaminated semen [10]. However, the role of dam immunity in semen transmission of PCV2 has not been evaluated, although most swine herds are seropositive [1]. To add more complexity to the scenario, several PCV2 vaccines have become available in recent years and are currently being implemented to control PCVAD in the growing phase or in isolation facilities for sow farm replacement females. It is unknown whether the immunity induced by PCV2 vaccination can protect against fetal PCV2 infection. Thus, the objectives of this study were to determine if dam vaccination against PCV2 or dam immunity induced by previous PCV2 infection of the dam were sufficient to prevent fetal infection when dams were artificially inseminated with PCV2-spiked semen.

2. Materials and methods

2.1. Experimental design and animals

The experimental protocol was approved by the Iowa State University Institutional Animal Care and Use Committee. Nine multiparous conventional crossbred specific-pathogen-free (SPF) dams (Sus domestica) were included in the study. The dams were obtained from a source herd serologically negative for PCV2, porcine parvovirus (PPV), porcine reproductive and respiratory syndrome virus (PRRSV), swine influenza virus (SIV), and encephalomyocarditis virus (EMCV). Prior to AI, dams were moved to a BSL-2 facility and housed by group in separate rooms. Negative control dams in Group 1 (n = 3) were artificially inseminated with extended PCV2 DNA negative semen during estrus. Dams in Group 2 (n = 3) were vaccinated with a commercially available PCV2 vaccine per manufacturer's label instructions, 8 wk before AI with extended semen spiked with PCV2. Dams in Group 3 (n = 3) were challenged with PCV2 (strain NC-16485) intranasally 12 wk earlier and were artificially inseminated with extended semen spiked with PCV2 (Table 1). Dams were allowed to gestate and maintain pregnancy to term. At parturition, dams farrowed naturally, and presuckle serum samples were obtained from all live-born piglets. Immediately after collection of blood, all live-born piglets were euthanized (intravenous overdose of pentobarbital) for tissue collection and evaluation.

2.2. Prechallenge in Group 3 dams

Group 3 dams were inoculated with PCV2 (strain NC-16485) 12 wk before AI. Each dam received 5 mL of the PCV2 inoculum at a dose of $10^{4.2}$ tissue culture infectious dose ($TCID_{50}$) per milliliter intranasally.

Table 1
Experimental design, pregnancy and litter characteristics for negative controls (dams artificially inseminated with PCV2 negative semen) and vaccinated or PCV2-exposed dams inseminated with PCV2-spiked semen at estrus.

Group	Number	Treatment	Inoculation	Number Pregnant	Litter characteristics			
					Total born	Live-born	Dead	Mummified
1	3	None	None	3 of 3	32	31	1	0
2	3	PCV2 vaccination[1]	PCV2-spiked semen	2 of 3	28	24	2	2
3	3	Previous PCV2 exposure[2]	PCV2-spiked semen	3 of 3	29	25	1	3

[1]PCV2 vaccination occurred 8 wk prior to AI with PCV2-spiked semen.
[2]Inoculation with PCV2 occurred 12 wk prior to AI with PCV2-spiked semen.